

east and southeast gales occurred at all stations along the coast from Delaware Breakwater northward. While both Atlantic City and New York City reported a maximum velocity of 64 miles an hour, the velocity of 52 miles an hour from the east at Portland, Me., indicated that the storm was most severe in that locality. Due to the exposure of the anemometer at Portland the maximum wind velocity there seldom reaches 50 miles an hour.

The next disturbance to cause strong winds along the Atlantic coast was that of the 18th-19th, for which storm warnings were displayed along the New England coast the evening of the 18th. Again on the 20th warnings were displayed from Delaware Breakwater to Nantucket, Mass., in connection with a disturbance that moved rapidly eastward from Lake Erie to the southern New England coast.

At 8 p. m. of the 21st a disturbance of considerable energy was over the upper Ohio Valley and the southern Lake region and moving eastward, and southeast storm warnings were issued at 9:30 p. m. for the Atlantic coast from Cape Hatteras northward. These warnings were fully verified, the highest velocity reported being 56 miles an hour from the northwest at New York City.

The last storm warnings of the month were ordered during the afternoon and evening of the 30th from the Virginia Capes to Eastport, Me., in connection with a disturbance of marked intensity that moved rapidly from the lower Ohio Valley to New England. Several stations reported maximum velocities of between 45 and 50 miles an hour from the southeast.

Frost warnings were issued for portions of the South Atlantic and East Gulf States on the 1st and 2d, but no further warnings for the Southeastern States were required during the month, and none for any section until the 17th. During the week beginning on that date warnings were issued for limited areas in the Ohio Valley and the Middle Atlantic States.—*Charles L. Mitchell.*

CHICAGO FORECAST DISTRICT

The month, as a whole, was moderately warm and dry in the central and southern portions of the district, and wet and cold from northern Lake Michigan westward and northwestward across the Red River of the North Valley.

Special warnings issued during April were chiefly confined to those in anticipation of frost, but the season was somewhat later than the average, and, in consequence, warnings were not of much importance.

The principal storm of the month appeared beyond the Rockies on the 13th, and gradually developed and moved eastward, the center reaching the Middle Missouri Valley on the 15th, the Middle Mississippi Valley on the 16th, and the northern Lake region on the 17th. Heavy snow accompanied the storm in the Rocky Mountain region and northern Plains, and cold weather followed in its rear, frost being reported on the 18th to the southern limits of the region.

Livestock warnings were sent on the 15th to Nebraska and Wyoming; advices of frost to various points as occasion demanded; also advisory messages to open ports on Lake Michigan for strong shifting winds. The regular season for navigation did not commence until April 20.—*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT

The weather during April, 1924, was marked by several well-defined troughs of low pressure, which generally weakened in passing eastward over this district; but the last trough of the month, passing eastward on the 28th-30th, increased in intensity.

The month opened with cool weather and extensive frosts in the interior sections, but thereafter the areas of high pressure following the troughs did not carry cold weather far southward, frosts being generally limited to the northwestern portion and freezing temperature to the extreme northwestern portion of the district. Ample notice was given for all frosts and freezes and warnings were sent also to stockmen for the freezes that occurred in the Texas Panhandle and northwestern Oklahoma on the 17th and 26th. The dates of frost warnings, which were issued mostly for the northwestern portion of the district and occasionally for northern Arkansas, were the 1st, 9th, 17th, 18th, 26th, 29th, and 30th.

On the morning of the 25th, in the southern end of a long trough of low pressure, a disturbance appeared over the Rio Grande Valley. Southeast storm warnings were issued at 8:30 a. m. for strong southerly winds and squalls on the Texas coast. The wind increased considerably and moderate to fresh gales occurred during the afternoon, though the morning and night weather maps showed only moderate pressure gradient, and the storm diminished in intensity thereafter. There were no storms without warnings. Small craft warnings were advised for the Texas coast on the 15th, 16th, 25th, and 26th.

Fire-weather warnings were sent to addresses in Oklahoma and Arkansas on the 15th and 24th and conditions occurred as forecast.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

On the morning of the 15th a pronounced area of low pressure was central over southeastern Wyoming, while the barometer was moderately high and rising over the North Pacific States. Cold wave and livestock warnings were issued for northern and eastern Colorado and northeastern Arizona, and livestock warnings alone for northern New Mexico. The ensuing weather was in full agreement with the warnings.

Another pronounced low-pressure area began crossing the district from the west on the 23d, being followed by high pressure from the northwest, consequently forecasts of rain turning to snow and colder weather were issued for the sections within its influence, timed to accord approximately with the pressure movements. Pressure gradients intensified during the day and night sufficient to produce a cold wave in northeastern Colorado.

Another disturbance, which manifested but little energy in crossing the district, developed marked energy by the morning of the 29th over southern Kansas and Oklahoma, while a high was building up to the northwest, consequently livestock warnings were issued for eastern Colorado for colder weather, with snow. The ensuing fall in temperature was comparatively small and precipitation was mostly rain on the lower ranges, but snow on the more elevated ones.

Frosts and temperatures near or below freezing were of very frequent occurrence during the month, and the number of warnings to interested districts was correspondingly great.

Warnings were already being issued at the beginning of the month for the fruit districts in which protective measures are taken in southern New Mexico, and fruit advanced so as to become susceptible to injury by April 9th in southeastern Colorado, by the 12th in the Colorado Valley in Colorado, and about the 29th in the Gunnison Valley in Colorado.

Warnings of expected frosts of a less serious character were issued as follows:

For all of southern New Mexico on the 16th, 17th, 25th, and 26th; for extreme southeastern New Mexico on the

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RIVERS AND FLOODS

By H. C. FRANKENFIELD, Meteorologist

5th, 12th, 19th, 20th, 24th, and 27th; for northern New Mexico on the 27th, 29th, and 30th; for southeastern Colorado on the 12th, 18th, 19th, 20th, and 21st; for the Colorado Valley in Colorado on the 14th, 18th, 19th, and 21st; for all of Colorado on the 27th and 30th; for southeastern Arizona on the 15th, 17th, 25th, and 26th; for south central Arizona on the 25th; and for northwestern Utah on the 17th, 18th, 19th, 21st, 24th, 25th, 26th and 27th. These warnings were generally justified by the actual occurrence of frost or by the critical temperatures for frost.

Warnings of more severe temperatures embracing those close to or below freezing were issued as follows: 1st and 3d, extreme southeastern New Mexico; 9th, southeastern Colorado, 15th, Colorado and Utah; 16th Colorado, Utah, and extreme southeastern New Mexico; 17th, Colorado and extreme southeastern New Mexico; 24th, Colorado; 25th and 26th, Colorado and northern and extreme eastern New Mexico; and the 29th for Colorado. In nearly every case these warnings were fully verified.—*Lawrence C. Fisher.*

SAN FRANCISCO FORECAST DISTRICT

April in the San Francisco Forecast District was usually dry, due to the persistence of ocean high-pressure areas impinging upon the California and Oregon coasts. They prevailed, with slight variations, practically during the entire month. There were about as many Bering Sea and Gulf of Alaska storms as usual, but they moved inland too far north to cause any great amount of rain in the Pacific States. On the 20th a small disturbance was located off the California coast, which moved inland on the 23d, and in doing so caused a small amount of rain in the southern half of California. Rain also fell during the first few days of April quite generally throughout the district. Nearly all the storms that occurred passed from the ocean inland over northern British Columbia to Alberta and thence formed a trough of low pressure that extended south through Idaho and Nevada. The lower end of the trough when over southern Nevada received sufficient moisture from the ocean to cause some few showers in California and Nevada. The drought, however, in the former State is the worst that has been experienced since the establishment of the Weather Bureau, as up to the end of April only about 50 per cent of the normal rainfall has occurred in California. The droughty situation is worse in the northern portion of the State than in the southern, which is very unusual. The nearest approach to the present dry spell occurred during the season of 1897-98, when only 54 per cent of the normal amount of precipitation was received during that season and the southern part of the State suffered most, which is just the opposite to the present conditions.

Frost warnings were issued in the north Pacific States on 15 days and in northern California on two days. No damage was done by frosts in California; but they were unusually severe in portions of the north Pacific States, where crops were badly injured.

Storm warnings were displayed at the entrances to the Gulf of Georgia and the Strait of Fuca and at the mouth of the Columbia River on the 17th. Small-craft warnings were ordered at a few places on the 15th, 18th, and 23d.

Livestock warnings were issued on April 3 for eastern Oregon, Nevada, and southern Idaho; and fire-weather warnings were issued on the evening of the 24th for northern California. All of these warnings were justified except the fire-weather warning was not followed by as high temperature as expected.—*E. A. Beals.*

At the close of March, 1924, the Ohio River was in flood as far down as the mouth of the Great Kanawha River. The crest stage at Point Pleasant, W. Va., on the Ohio River was 44.5 feet on April 2. Below Point Pleasant, flood stages were not recorded until Cloverport, Ky., was reached. From this place to Shawneetown, Ill., just below the mouth of the Wabash River, the crest stages varied from 0.7 foot to 4.1 feet above the flood stages, the greatest excess at Shawneetown. Below Shawneetown the river was 5 or more feet below the flood stage, and the crest passed into the Mississippi River on April 11, with a stage of 40.7 feet at Cairo, Ill., reaching the Gulf of Mexico about April 25.

The flood was very accurately forecast and there was no damage of consequence, although some inconvenience and delay in farm work resulted. In the vicinity of Shawneetown, Ill., property to the amount of \$10,000 was saved through the warnings.

There were no floods of moment in the tributary streams in the State of Ohio. Such as occurred were properly forecast and the damage was very small. The flood in the White River of Indiana and its forks was also moderate, the crest stages ranging from about 2 to 5 feet above the flood stage. Owing to the backwardness of the growing season the damage was small, probably not over \$10,000. However, the warnings allowed the removal of considerable property from bottom lands.

The flood in the Wabash River of Indiana and Illinois attained fair proportions on account of the rapid melting of the heavy snows that fell over northern Indiana on March 20-21. The flood was most marked at La Fayette, Ind., where the crest stage of 21.2 feet on March 31 was 10.2 feet above the flood stage. Warnings were issued as often as necessary, and there were no losses of livestock nor other portable property. Losses from other sources, flooding of basements, highways, etc., amounted to about \$4,000. The value of property saved through the warnings was about \$5,000.

Flood warnings for the lower Connecticut Valley were issued on April 7 after a 24-hour rainfall that was excessive over the lower valley, and at 9 p. m., April 8, the Connecticut River at Hartford, Conn., reached a stage of 20.7 feet, 4.7 feet above flood stage. There was no damage done along the main stream, but the smaller rivers were dangerously high, especially the Farmington and Park Rivers. It was impossible to obtain estimates as to the amount of damage done.

Warnings were again issued on April 15 for the lower valley and on April 18 and 19 for the entire valley after the heavy rains that began during the afternoon of April 18. The flood was a moderate one and the warnings were well verified. No damage was reported.

The heavy rains of April 6-7, together with some melted snow, also caused a marked flood in the Hudson River at Troy and Albany, N. Y., the river reaching 20.3 feet at Troy and 14.6 feet at Albany, 5.3 and 2.6 feet, respectively, above the flood stages. Warnings were issued promptly and the reported losses were small, only about \$7,400, while the saving through the warnings was perhaps \$2,500.

Flood conditions in the north branch of the Susquehanna River were very similar and were equally well forecast. The damage done, however, was somewhat greater, more than \$25,000, probably because a larger area was covered.

There were some minor floods in the rivers of the south Atlantic system and in the upper Coosa River of Georgia